

Fish community associated with shallow beachrock rocky reef of Ligurian Sea (NW Mediterranean)

by

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RÉSUMÉ. - Communauté de poissons associée au littoral rocheux à "beachrock" de la mer Ligure (NO Méditerranée).

La communauté de poissons associée au littoral rocheux le long de la côte ligure occidentale (NO Italie, mer Méditerranée) a été étudiée par un recensement visuel en juillet 2002 et en février 2003. Deux sites ont été choisis pour la présence d'un affleurement superficiel de "beachrock", dont le plateau présente une pente douce jusqu'à 2-3 m de profondeur. Le suivi en plongée montre que ce littoral rocheux abrite un peuplement de poissons diversifié (43 espèces), avec moins d'espèces recensées dans le site I qu'au site II (28 vs 38) et une légère différence pour la densité moyenne de poissons entre le site I et le site II ($138,33 \pm 39,96$ vs $213,83 \pm 64,03$ individus par transect). Les résultats montrent une différence dans la taille moyenne des poissons et dans la composition trophique des communautés entre les sites d'échantillonnage. Ces différences, légères, sont à mettre en relation avec les conditions hydrodynamiques. Cette étude donne une description préliminaire des communautés de poissons associées à ces substrats durs et souligne l'importance de ce type de milieu pour le maintien des communautés côtières de poissons.

Key words. - Fish community - MED - Ligurian coast - Beachrock.

In the last decade growing interest has been paid to the study of the relationship between fish communities and substrate type, especially for shallow rocky reef, a very important habitat in maintaining littoral fish population (Guidetti, 2000). Fish communities of tropical coral reefs have been widely studied (Sale, 1991 and references therein). Most of the available studies on Mediterranean rocky reef fish have focused on the effect of factors such as biological interactions, for instance grazing (Sala and Boudouresque, 1997), predation and reproduction (Harmelin, 1987; Guidetti and Bussotti, 2000), physical factors, such as habitat complexity that provide shelter for many littoral species (Garcia-Rubies and Macpherson, 1995), hydrodynamic forces (Bell, 1983) and mineralogical nature of the substrate (Guidetti and Cattaneo-Vietti, 2002). Beachrock consists of carbonate-cemented rock of varying composition occurring in the upper tidal zone of many warm temperate, subtropical and tropical marine environments. In the Ligurian Sea these beachrocks are constituted by a dominance of Mg-calcite with high Mg-content and with age ascribing to the Holocene (Fierro *et al.*, 1974). Although geological and geochemical studies of beachrock are relatively abundant in the literature, very little is known about the biology, except for studies carried out in tropical waters, focused on faunistic and floristic accounts (e.g., Brattström, 1992). This paper aimed at investigating distribution patterns of the fish community associated with beachrocks rocky reef in the western Ligurian Sea. The possible role of exposition to wave movement in affecting indirectly the structure of fish community is discussed.

MATERIALS AND METHODS

Two sites were chosen in the Ligurian sea for the presence of beachrock (I: N 44° 11.07'; E 008° 24.41' and II: N 44° 11.35'; E 008° 24.85') (NW Mediterranean, Italy; Fig. 1). These geological formations are composed of a series of shallow platforms which extend parallel to the coast line, 250 m long and from 25 to 50 m wide, with a plateau sloping gently from the water surface to 2-3 m depth, with the outer edge dropping on sands at 4-6 m depth (Fierro *et al.*, 1974). Site I is more exposed to wave action than site II. The algal community was characterised mainly by *Acetabularia acetabulum*, *Padina pavonica* and *Dictyota dichotoma*: a well-structured *Cystoseira* sp. canopies was detected at site I whereas absent at site II.

The sampling was carried out in July 2002 and February 2003. Data on coastal fish community were collected between the surface and 3 m depth by visual census, performed by snorkeling along 25 m long and 5 m wide transects according to Harmelin-Vivien *et al.* (1985). 36 censuses were performed, 18 per period (9 per sites). The total number of fish was estimated by classes of abundance on a basis of geometrical progression of 2 (1; 2-5; 6-10; 11-30; 31-50; 51-100; 101-200; 201-500; > 500) (Harmelin-Vivien *et al.*, 1985), considering three size classes (small, medium, large), estimated according to the maximum total length of each species (Fischer *et al.*, 1987). The calculation of fish density (number of individuals per 125 m²) was made considering the mid-point of each class. Size frequency distributions were analysed for the whole fish community. With regard to the trophic composition, the assignment of feeding-guilds to each species was made according to the Bell and

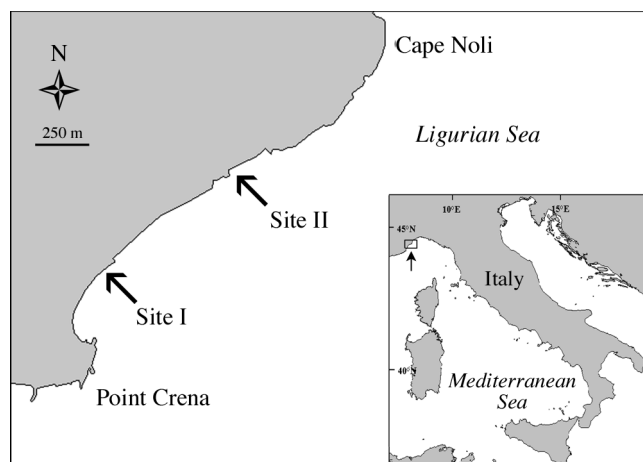


Figure 1. - Study area with the two sampling sites. [Zone étudiée avec les deux sites d'échantillonnage.]

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Table I. - List of species recorded at two sites and during the two study periods with mean number of individuals per 125 m² ($\pm$ S.E.) of each species. “-”: absent. [Liste des espèces observées sur les deux sites pendant les deux périodes d'étude et nombre moyen ($\pm$ S.E.) d'individus de chaque espèce sur 125 m².]

Family	Species	Site I		Site II	
		Jul. 2002	Feb. 2003	Jul. 2002	Feb. 2003
Atherinidae	Undetermined	3.4 (2.3)	3.3 (3.1)	188.9 (66.6)	17.8 (7.0)
Belonidae	<i>Belone belone</i> (Linnaeus, 1761)	-	-	0.1 (0.1)	-
Blenniidae	<i>Aidablennius sphynx</i> (Valenciennes, 1836)	-	1.2 (0.5)	0.3 (0.2)	0.4 (0.2)
	<i>Coryphoblennius galerita</i> (Linnaeus, 1758)	0.4 (0.2)	-	-	-
	<i>Lipophrys adriaticus</i> (Stein. & Kolomb., 1883)	-	0.1 (0.1)	-	-
	<i>Lipophrys canevai</i> (Vinciguerra, 1880)	-	-	-	0.2 (0.2)
	<i>Lipophrys trigloides</i> (Valenciennes, 1836)	-	-	0.1 (0.1)	-
	<i>Parablennius gattorugine</i> (Brünnich, 1768)	0.4 (0.2)	0.1 (0.1)	-	0.1 (0.1)
	<i>P. incognitus</i> (Bath, 1968)	0.3 (0.2)	-	0.1 (0.1)	-
	<i>P. sanguinolentus</i> (Pallas, 1811)	0.8 (0.4)	0.1 (0.1)	0.2 (0.2)	0.2 (0.2)
	<i>P. tentacularis</i> (Brünnich, 1768)	0.3 (0.2)	-	0.2 (0.1)	-
	<i>P. zvonimiri</i> (Kolombatovich, 1892)	0.3 (0.2)	0.1 (0.1)	0.1 (0.1)	-
Carangidae	<i>Trachinotus ovatus</i> (Linnaeus, 1758)	0.3 (0.3)	-	-	-
	<i>Spicara meana</i> (Linnaeus, 1758)	-	-	-	0.22 (0.15)
Gobiidae	<i>Gobius bucchichi</i> (Steindachner, 1870)	0.1 (0.1)	0.1 (0.1)	0.3 (0.2)	-
Labridae	<i>Coris julis</i> (Linnaeus, 1758)	7.2 (4.3)	1.0 (0.5)	5.8 (1.7)	0.1 (0.1)
	<i>Labrus merula</i> (Linnaeus, 1758)	-	-	0.4 (0.2)	-
	<i>L. viridis</i> (Linnaeus, 1758)	-	-	0.2 (0.1)	0.1 (0.1)
	<i>Symphodus cinereus</i> (Bonnaterre, 1788)	-	0.1 (0.1)	0.4 (0.2)	-
	<i>S. ocellatus</i> (Forsskål, 1775)	-	-	0.2 (0.2)	-
	<i>S. roissali</i> (Risso, 1810)	1.8 (0.6)	0.9 (0.4)	0.6 (0.2)	0.2 (0.1)
	<i>S. rostratus</i> (Bloch, 1797)	1.4 (1.0)	-	0.6 (0.6)	-
	<i>S. tinca</i> (Linnaeus, 1758)	1.9 (0.6)	-	2.6 (1.2)	0.1 (0.1)
	<i>Thalassoma pavo</i> (Linnaeus, 1758)	0.1 (0.1)	-	-	-
Moronidae	<i>Dicentrarchus labrax</i> (Linnaeus, 1758)	0.8 (0.4)	-	-	-
Mugilidae	Undetermined	48.0 (11.3)	4.6 (3.0)	16.3 (11.1)	-
Mullidae	<i>Mullus surmuletus</i> (Linnaeus, 1758)	-	0.1 (0.1)	5.8 (1.8)	0.2 (0.1)
Pomacentridae	<i>Chromis chromis</i> (Linnaeus, 1758)	-	-	16.7 (16.7)	1.1 (0.6)
Serranidae	<i>Serranus cabrilla</i> (Linnaeus, 1758)	-	-	0.2 (0.1)	0.1 (0.1)
	<i>S. scribe</i> (Linnaeus, 1758)	-	-	0.2 (0.1)	-
Sparidae	<i>Boops boops</i> (Linnaeus, 1758)	-	-	-	2.2 (2.2)
	<i>Diplodus annularis</i> (Linnaeus, 1758)	-	-	1.9 (0.7)	-
	<i>D. puntazzo</i> (Cetti, 1758)	-	0.1 (0.1)	0.2 (0.1)	-
	<i>D. sargus</i> (Linnaeus, 1758)	28.3 (8.3)	0.4 (0.3)	12.8 (3.3)	4.4 (1.5)
	<i>D. vulgaris</i> (Geoffroy Saint-Hilaire, 1817)	21.4 (3.0)	11.2 (5.8)	23.1 (5.8)	0.9 (0.7)
	<i>Lithognathus mormyrus</i> (Linnaeus, 1758)	1.4 (1.0)	-	6.4 (4.2)	-
	<i>Oblada melanura</i> (Linnaeus, 1758)	21.6 (5.7)	0.1 (0.1)	15.8 (8.7)	7.6 (6.6)
	<i>Pagellus acarne</i> (Risso, 1826)	-	13.3 (9.4)	9.7 (6.9)	25.6 (16.2)
	<i>Sarpa salpa</i> (Linnaeus, 1758)	86.1 (30.5)	15.6 (6.5)	36.1 (9.7)	14.2 (7.3)
Sphyraenidae	<i>Sphyraena viridensis</i> (Cuvier, 1829)	-	-	4.6 (4.4)	-
Syngnathidae	<i>Syngnathus typhle</i> (Linnaeus, 1758)	-	-	-	0.1 (0.1)
Synodontidae	<i>Synodus saurus</i> (Linnaeus, 1758)	-	-	0.1 (0.1)	-
Tripterygiidae	<i>Tripterygion tripteronotus</i> (Risso, 1810)	1.2 (0.4)	0.1 (0.1)	0.3 (0.2)	0.2 (0.1)
Mean number of individuals ($\pm$ S.E.)		223.9 (37.3)	52.8 (13.1)	351.4 (58.7)	76.2 (23.1)
Total mean number of individuals ($\pm$ S.E.)		138.3 (40.0)		213.8 (64.0)	

Harmelin-Vivien (1983) classification, based on the type and size of prey: 1) herbivores (*Sarpa salpa*); 2) microcarnivores (*Boops boops*, *Oblada melanura*, *Spicara maena*, *Chromis chromis*); 3) mesocarnivores type I (mainly Labridae), feeding on molluscs and small crustaceans; 4) mesocarnivores type II (Sparidae excluding

B. boops and *O. melanura*, and Gobiidae), preying on benthic invertebrates; 5) macrocarnivores (Serranidae, Moronidae and Sphyraenidae), feeding on fish, large crustaceans and cephalopods.

The number of species and mean fish density values (number of individuals per transect – 125 m²) were calculated both per site and

period. Analysis of variance (ANOVA) was applied to assess the difference in mean number of species and mean number of individuals of fish per 125 m², using site and time as fixed factors. Homogeneity of variances was tested by Cochran C-test (Zar, 1984). χ^2 tests were realized to analyse differences in size and trophic categories.

RESULTS

A total of 43 fish taxa were recorded. Atherinids and mugilids were not identified at the species level due to the difficulty of determination by *in situ* observations. Three families included the highest number of species: Blenniidae (10), Labridae (9) and Sparidae (9) (Tab. I). The total number of species was greater at site II than at site I (38 vs 28) and greater in July than in February (site I: 22 vs 19 and site II: 33 vs 21). The mean number of individuals ($\pm$ SE) of fish per 125 m² was greater at site II than at site I (213.83 $\pm$ 64.03 vs 138.33 $\pm$ 39.96), and greater in July than in February (site I: 223.89 $\pm$ 37.36 vs 52.78 $\pm$ 13.12 and site II: 351.44 $\pm$ 58.67 vs 76.22 $\pm$ 23.12) (Tab. I).

Analysis of variance showed that the difference in number of individuals and species per 125 m² was significant among periods (F = 2849.47, $p < 0.05$ and F = 544.44, $p < 0.05$ respectively), while there is no significant statistical difference among sites (F = 129.73, n.s. and F = 42.25, n.s. respectively).

Gregarious species (mainly Atherinidae, *B. boops*, *C. chromis*, *O. melanura* and *S. meana*) were the most numerous in both sites (65.2% at site I and 74.1% at site II), followed by nectobenthic species, mainly Labrids, Sparids and Serranids (32.7% at site I and 25.2% at site II) and cryptic species, such as Blenniids, Gobiids and Tripterygiids (2.1% at site I and 0.7% at site II).

Taking into account demographic structure, small size individuals were dominant at site I (small = 61%; medium = 34%; large = 5%), and medium size individuals at site II (small = 39%; medium = 57%; large = 5%) ($\chi^2 = 11.081$, $p < 0.01$).

With regards to trophic structure, the fish community was characterised by a higher frequency of herbivores individuals at site I (herbivores = 47%; microcarnivores = 10%; mesocarnivores type I = 7%; mesocarnivores type II = 36%; macrocarnivores = 0%), while at site II there was a predominance of mesocarnivores - type II (herbivores = 26%; microcarnivores = 22%; mesocarnivores type I = 6%; mesocarnivores type II = 44%; macrocarnivores = 3%). ($\chi^2 = 13.421$, $p < 0.01$).

DISCUSSION

The fish community associated with Ligurian Sea beachrocks shows an important number of species, comparable with the fish community described by Molinari and Tunesi (2003) from a rocky reef in a nearby area. The present study confirms the preference of many cryptic fish to live in shallow rocky reef, such as fish species belonging to Blenniidae (Nieder *et al.*, 2000). The ichthyofauna associated with the studied rocky reefs shown significant differences comparing species richness and mean number of individuals values recorded during the two sampling times, while slight differences were detected comparing the two studied sites. The fish community seems to be affected by the exposure from the main wave movement (site I more exposed than site II). Actually the absence at site I of some sedentary species such as *Serranus cabrilla*, *S. scriba* and *S. saurus*, and other demersal species that prefer well

vegetated habitat such as Labrids (Garcia-Rubies and Macpherson, 1995), *Diplodus annularis*, and *Syngnathus typhle* could be related with the stronger action of wave movement that mainly produces the erosion of beachrock surface and consequently induces a limited number of holes and crevices and a poor benthic assemblage (macroalgae and zoobenthos). The relevant occurrence in this shallow rocky reef of juvenile fish are in agreement with previous studies conducted both in the Ligurian Sea (Tunesi *et al.*, 1997) and in other Mediterranean regions (Harmelin-Vivien *et al.*, 1995; Garcia-Rubies and Macpherson, 1995; Guidetti and Bussotti, 2000). The analysis of the trophic composition put in evidence the importance of herbivores (*Sarpa salpa*) in vegetated rocky reef, underlining the preponderant role played by this species in the differentiation of algal communities in the Mediterranean (Verlaque, 1990) and, consequently, the abundance and diversity of the macrofauna (Schneider and Mann, 1991) associated with phytobenthos. This ultimately reflects the relevant occurrence of the mesocarnivores type II (Garcia-Rubies and Macpherson, 1995).

In conclusion, this study provides preliminary elements to describe fish community associated with beachrock rocky reef. On the basis of this study, a sampling design is necessary to investigate, on a wider spatial scale, the effects of environmental factors in structuring fish community of shallow Mediterranean rocky habitats.

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